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The aims and extent of Agricultural Meteorology

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1. Introduction

Life demands food. The production of food depends on the correct understanding of the four main factors:- plant and animal genetic material, climate, soil and man. In order to make successful plans to develop the food production of any area, it is essential to understand the inter-relationship between these factors. By so doing it is possible to devise and implement a system of land use which is not only efficient in itself but is stable in time, that is to say, it is capable of continuance without diminishing efficiency, or irreversible loss of resources.

The aim of a biometeorological programme is therefore to make the maximum use of meteorology in food production. This involves putting into practice all reliable existing knowledge, and at the same time carrying out such fundamental and field research as will increase the volume, validity and value of such interdisciplinary knowledge.

2. Types of Agricultural Problem

In an attempt to comprehend the full extent of the problems it is convenient to make the following kind of classification:-

(a) Yields (or Production Factors)

(i) Crops: Germination
Growth, including quantity and quality. Harvest.

(ii) Animals and animal products: Conception, pregnancy and birth: Growth, including quantity and quality: Product processing.

(b) Dangers (or Adverse Production Factors)

(i) The pests and diseases of crops

(ii) The pests or parasites and diseases of animals

(iii) The pollution of the air, the soil, the crop and the animal

(iv) The environmental stress (heat, cold, damp, wind etc) on crop and animal

(v) Drought

(vi) Erosion, wind or water

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(vii) Frost.

(viii) Fire.

(ix) Weeds, or competition from non productive elements (e.g. predators, animal damage to growing crops).

(x) Losses during storage or transport.

(c) Improvement Techniques

(i) Irrigation.

(ii) Shelter from the wind.

(iii) Shade from sun.

(iv) Anti-frost measures.

(v) Anti-erosion measures.

(vi) Soil cover, mulches.

(vii) Plant cover, glass and plastic: artificial climates.

(viii) Animal housing: artificial climates.

(ix) Food storage and transport: artificial climates.

(x) Spraying of crops: veterinary treatments.

(xi) Fetilizers.

(xii) Crop rotations: systems of management.

Many of these problems have their immediate counterpart in section (b), but they have to be considered separately because of their secondary or side-effects. An assessment of danger is one problem; the assessment of defence or amelioration has to include a full consideration of the consequences of action. The protection against one danger may imply an increased risk in another category.

(d) The tactics of Food Production

(i) Choice of crop or crop variety.

(ii) Choice of (farm) animal or animal breed.

(iii) Choice of design and extent of farm machinery.

(iv) Choice of methods of soil cultivation.

(v) Timing of farm operations; crop and animal husbandry.

These problems include the season-to-season and day-to-day decisions in agriculture, horticulture and forestry which involve a meteorological factor.

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(e) The Strategy of Food Production

(i) Land use: choice of type of agriculture: production planning.

(ii) Genetic planning: breeding programmes, plant and animal.

(f) Research on Fundamental Processes

Collaboration between research scientists, physicists, chemists, soil scientists and all branches of biological science - to elucidate the basic processes of the biosphere.

3. The Meteorological Parameters

Although these are listed separately hereunder, it is axiomatic that they rarely can be considered in isolation. Combination of many or even all the parameters is needed for a complete solution of any particular problem. It is required to know the distribution in time and space of the following:-

Radiation and Light: quantity and quality: incoming and outgoing.
Temperature: air, surface and soil.
Moisture: air, surface and soil.
Rainfall, Snowfall.
Hail, Lightning.
Wind.
Evaporation, Transpiration: Potential and Real.
Meteorological Processes (such as boundary layer physics, origin, transport and deposition of airborne material; heat transfer etc).
Climatological Processes (such as circulation patterns, climatic change).
Assessment of climatic risks.
Weather forecasting (short-term, seasonal, climatic; in other words in days, months or decades).

In any one particular problem or area, it is often found that only a few of these parameters are of first order importance. If it can be safely assumed that the other factors are of secondary importance, the problem becomes simplified and useful interim solutions can be found and utilized.

4. Data acquisition, storage and accessibility

In comparison with most other sciences the state of affairs regarding meteorological data is in a class of its own, which is not to say that it is not capable of improvement. Much of the activities of the World Weather Watch of the World Meteorological Organization is concerned with this organizational problem.

In regard to the inventory and assessment of biological data the situation is for less satisfactory. The present inadequacy is greatly handicapping inter-disciplinary investigation and research.

5. Data Analysis

The significance of enviromental data must be expressed in terms of its biological effects. This is a process of interpretation or translation from the language of one science to the langauge of another. It must be carried

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out at two types of level:- the basic or long term level of scientific truth
:- the interim or semi-empirical level of immediate use
with inter-communication between the levels as and when necessary.

The work cannot be done by one science or one scientist alone. The aim of the agro-meteorologist is to become a useful member of a multi-science team. The mutual assistance programme between the scientific disciplines can range from collaboration involving adequate consultation to active side-by-side co-operation on one problem at one site at one time.

A complete solution of a problem is not always attainable or even desirable. It may be sufficient to identify and quantify the dominant influences concerned.

6. Training

Very few training courses or systems of education exist whereby scientists can learn to become useful co-workers in inter-disciplinary science.

This problem must be tackled urgently and efficiently, otherwise the multitude of practical problems which await solution will remain unapproached or carried out in an inadequate manner due to the non-existence of the correct type of consultant, project director, or team member.

Agencies, both governmental and non-governmental, research organizations and universities should consider what can best be done to overcome this lack of suitable man-power. The solution of practical problems demands the application of many species of scientific knowledge. It is sheer wishful thinking to imagine that an expert in one branch of science is equally capable of making judgements in a realm of science with which he is unacquainted.

The bridging of the gaps between sciences is a matter of high educational priority.

7. Application and Value of Results

If a resonably acceptable inter-relationship between two or more types of scientific phenomena is established as a result of co-operative research, it still remains sterile unless it is put to practical operational use. The non-use of existing knowledge is at best stupid, and at worst is a crime against humanity as it can lead to an irreversible degradation of human life.

Advances in bio-meteorology, or any other similar science, must therefore be made known to the following categories:-

Administrators
Planners
Educationalists at various levels
Land owners, state, organizational, or personal
Land workers
Public at large, so that they may understand decisions which could affect them indirectly.

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The ways in which this can be done will vary in accordance with the political and sociological structures of the areas concerned. It is therefore not possible to lay down universal methods of procedure. It may indeed be true to say that the biggest present obstruction to progress in some cases is not lack of scientific knowledge but lack of sensible application thereof.

It is always difficult to assess the value of increase of basic scientific knowledge because no one yet knows to what use this knowledge is to be put. In applied science the assessment is easier, but still not simple.

Clearly each case has to be argued on its own merits, but one example will give an idea of the order of magnitude of the benefits which are attainable.

If the meteorological factors in the epidemiology of one animal disease in one area can be identified so that timely advice can be given and action taken to prevent disease loss, then the subsequent gain in production can be one hundred times more in value than the cost of the research and operational procedure. This implies a return of capital of some 10,000 per cent.

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